16083 - Water and methane in a juvenile transiting exoplanet

Cycle: 27, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) V-V1298-TAU	WFC3/IR	10	03-Sep-2020 17:00:49.0	yes

10 Total Orbits Used

ABSTRACT

We propose to observe the transit spectrum of recently discovered young warm Jupiter V1298 Tau b using the HST/WFC3 instrument near 1.4 microns. We will measure the atmospheric properties of this likely inflated gas giant (~23Myr, 0.9 Jupiter radii, likely <90 Earth masses, 24 day period). At equilibrium temperature (650K), we expect the presence of methane in the atmosphere of this object, and we will have the precision to measure it. This will allow us to evaluate the equilibrium chemistry and temperature of the planet's atmosphere. We will place constraints on its

metallicity and the clouds/hazes present. We will compare our results to the atmospheric properties of young directly imaged planets to evaluate the influence of the location within the disk and the stellar irradiation on planetary compositions. This observation represents an opportunity for HST to yet again open a new chapter of exoplanet characterization of a completely unexplored class of planets. Our observations will inform and enable future studies with JWST.

OBSERVING DESCRIPTION

We will observe V1298 Tau b during a transit using time series spectroscopy with WFC3/G141. We will collect data with the WFC3/IR camera configuration in the spectroscopic scanning mode with the G141 grism. This will provide us with a high quality transit spectrum of our target in the 1.1-1.65 micron region. In order to achieve our science goals, we require high sensitivity. Since the target star is bright (H = 8.19), we will employ the bi-directional spatial scanning mode for WFC3 in order to maximize the photon-collecting efficiency and the duty cycle of the telescope. In order to maximize the duty cycle of the telescope and estimate the signal-to-noise of our observations, we use the PandExo HST open source tool. We use input transit spectroscopy models created with the ExoTransmit package (Kempton et al. 2016), assuming solar atomic abundances, and planet mass of 90M_Earth (conservative estimate). This approach allows us to maximize the duty cycle (not including occultation by Earth) to 65%, while avoiding mid-orbit buffer dumps. We will use NSAMP = 5 and SAMP_SEQ = SPARS25. We use GRISM256 aperture to limit interference from nearby bright stars. The exposure time calculations result in optimal scan rate of 0.230 "/s, resulting in scan heights of 170 pixels (21"). This observation is time critical - it will only work if the target star is observed for the duration of the entire transit, plus out-of-transit baselines before and after transit. To ensure adequate coverage of the unusually long transit, we will observe the light curve for 10 HST orbits. The transit duration is 7 hours or 4.4 orbits, and we allow 4.6 orbits total, or 7.4 hours for pre-ingress and post-egress baselines.

Visit

Proposal 16083, V1298 Tau b transit (01), implementation Thu Sep 03 21:00:54 GMT 2020

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR

Special Requirements: Period 24.14138191 D AND ZERO-PHASE HJD2457067.0490174

Diagnostics

(V1298 Tau b transit (01)) Warning (Orbit Planner): LONG SU LIKELY TO INTERSECT THE SAA

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	V-V1298-TAU	RA: 04 05 19.5970 (61.3316542d) Dec: +20 09 25.31 (20.15703d) Equinox: J2000	Proper Motion RA: 3.712731804600008E-4 sec of time/yr Proper Motion Dec: -0.016077000032055366 arcsec/yr Epoch of Position: 2015.5	V=10.12 H=8.191	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[EXTRA-SOLAR PLANET, EXTRA-SOLAR PLANETARY SYSTEM, K V-IV, T TAURI STAR]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; PHASE 0.9842 TO 0.9868	Sequence 1-2 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[1]***
2		(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.23,90.0 Degrees,Round trip	Sequence 1-2 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[1]***
3		(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 3-4 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[2]***
4		(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.23,90.0 Degrees,Round trip	Sequence 3-4 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[2]***

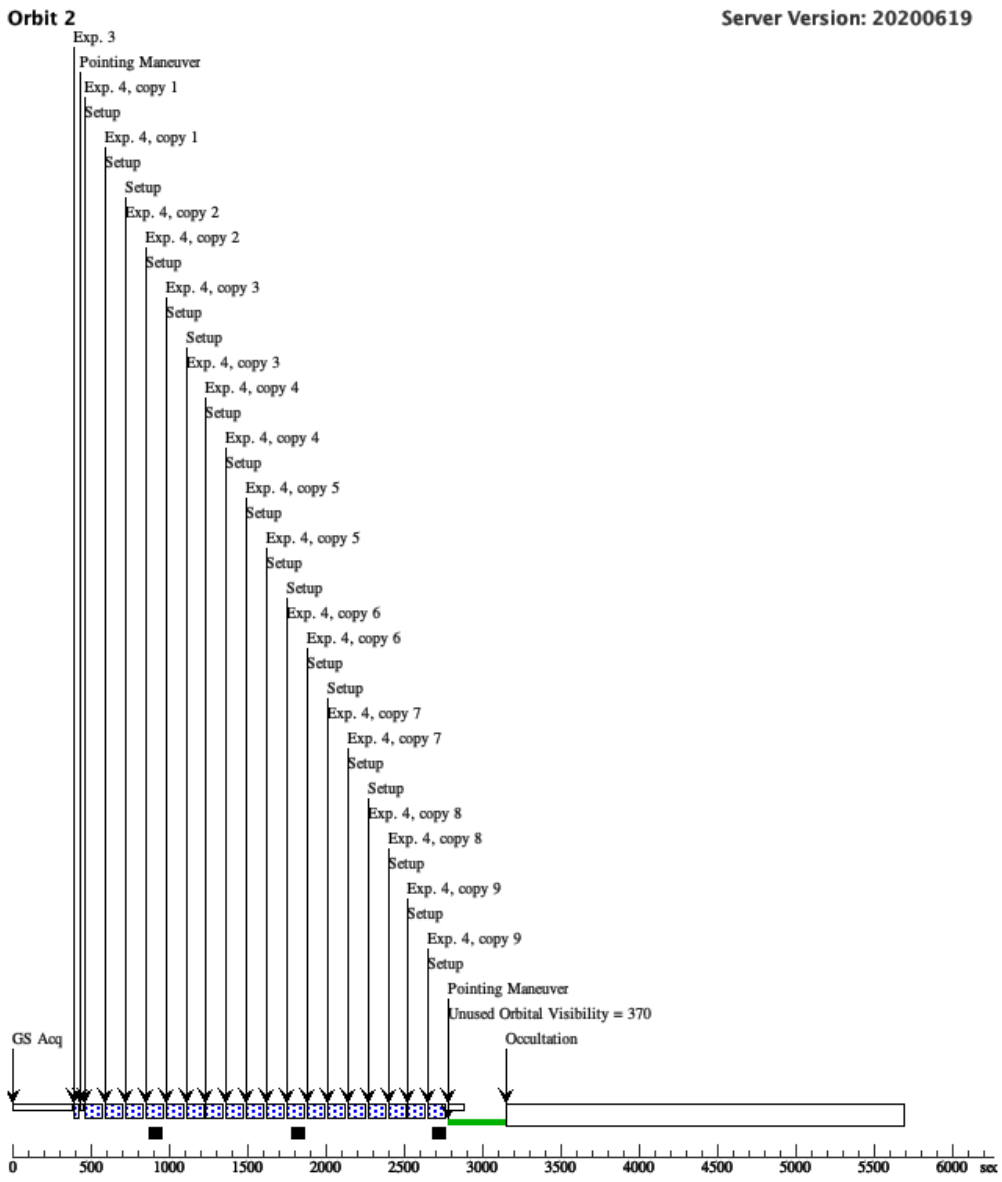
5	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 5-6 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[3]***
6	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 5-6 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[3]***
7	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 7-8 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[4]***
8	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 7-8 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[4]***

9	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 9-10 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[5]***
10	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 9-10 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[5]***
11	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 11-12 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[6]***
12	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 11-12 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[6]***

13	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 13-14 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[7]***
14	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 13-14 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[7]***
15	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 15-16 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[8]***
16	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 15-16 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[8]***

17	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 17-18 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[9]***
18	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 17-18 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[9]***
19	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	F126N	NSAMP=2; SAMP-SEQ=RAPID	POS TARG 0,0; NEW OBSET FULL ACQ	Sequence 19-20 Non-Int in V1298 Tau b transit (01)	0.55563 Secs (0.556 Secs) *[==>]*	 ***[10]***
20	(2) V-V1298-TAU	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=5; SAMP-SEQ=SPARS25	POS TARG 0,-12; SPATIAL SCAN 0.2 3,90.0 Degrees,Round trip	Sequence 19-20 Non-Int in V1298 Tau b transit (01)	89.661971 Secs X 9 (1613.915 Secs) *[==>(Copy 1, Forward)]* *[==>(Copy 1, Reverse)]* *[==>(Copy 2, Forward)]* *[==>(Copy 2, Reverse)]* *[==>(Copy 3, Forward)]* *[==>(Copy 3, Reverse)]* *[==>(Copy 4, Forward)]* *[==>(Copy 4, Reverse)]* *[==>(Copy 5, Forward)]* *[==>(Copy 5, Reverse)]* *[==>(Copy 6, Forward)]* *[==>(Copy 6, Reverse)]* *[==>(Copy 7, Forward)]* *[==>(Copy 7, Reverse)]* *[==>(Copy 8, Forward)]* *[==>(Copy 8, Reverse)]* *[==>(Copy 9, Forward)]* *[==>(Copy 9, Reverse)]*	 ***[10]***

Orbit Structure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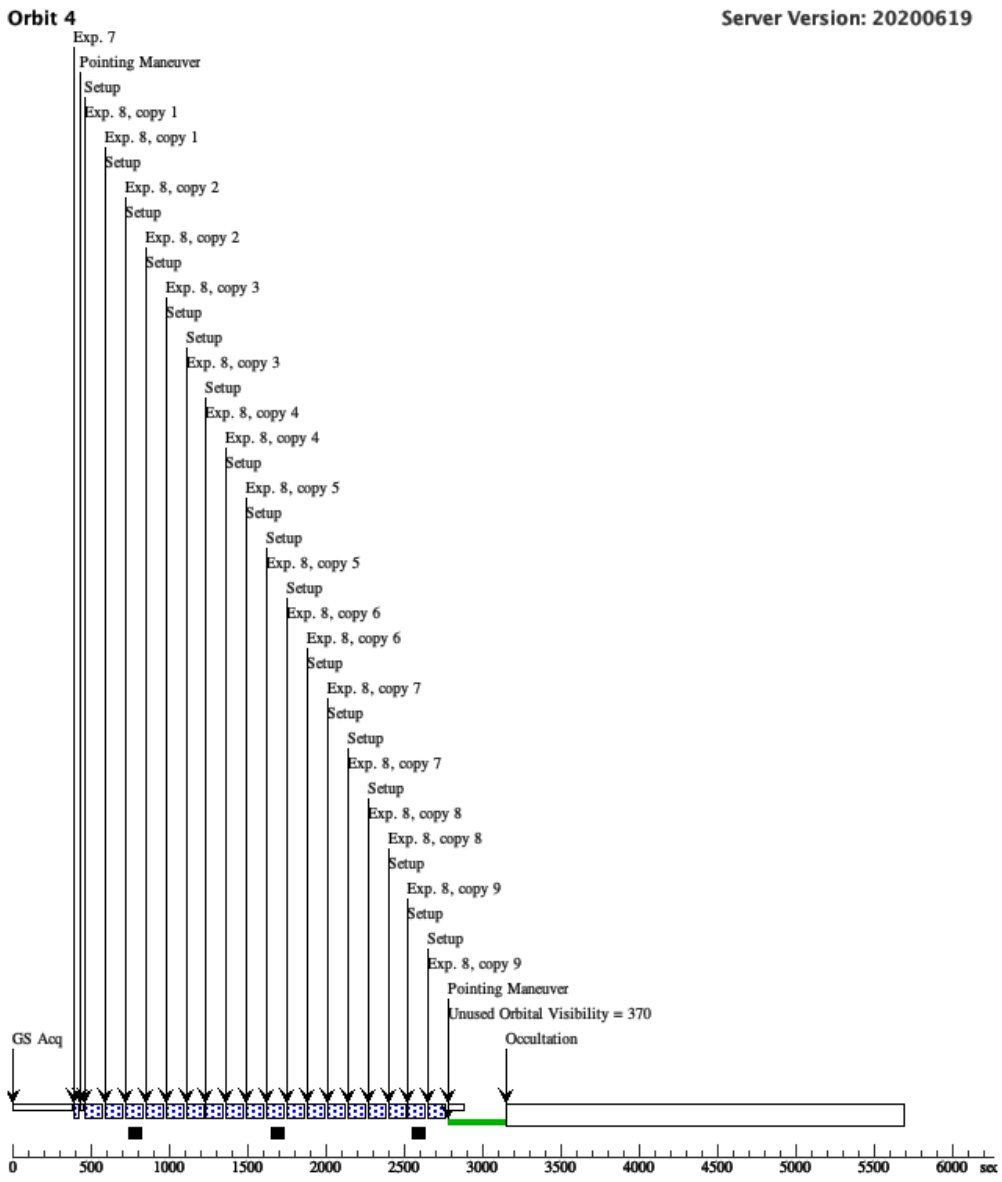
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Unused Orbital Visibility = 370
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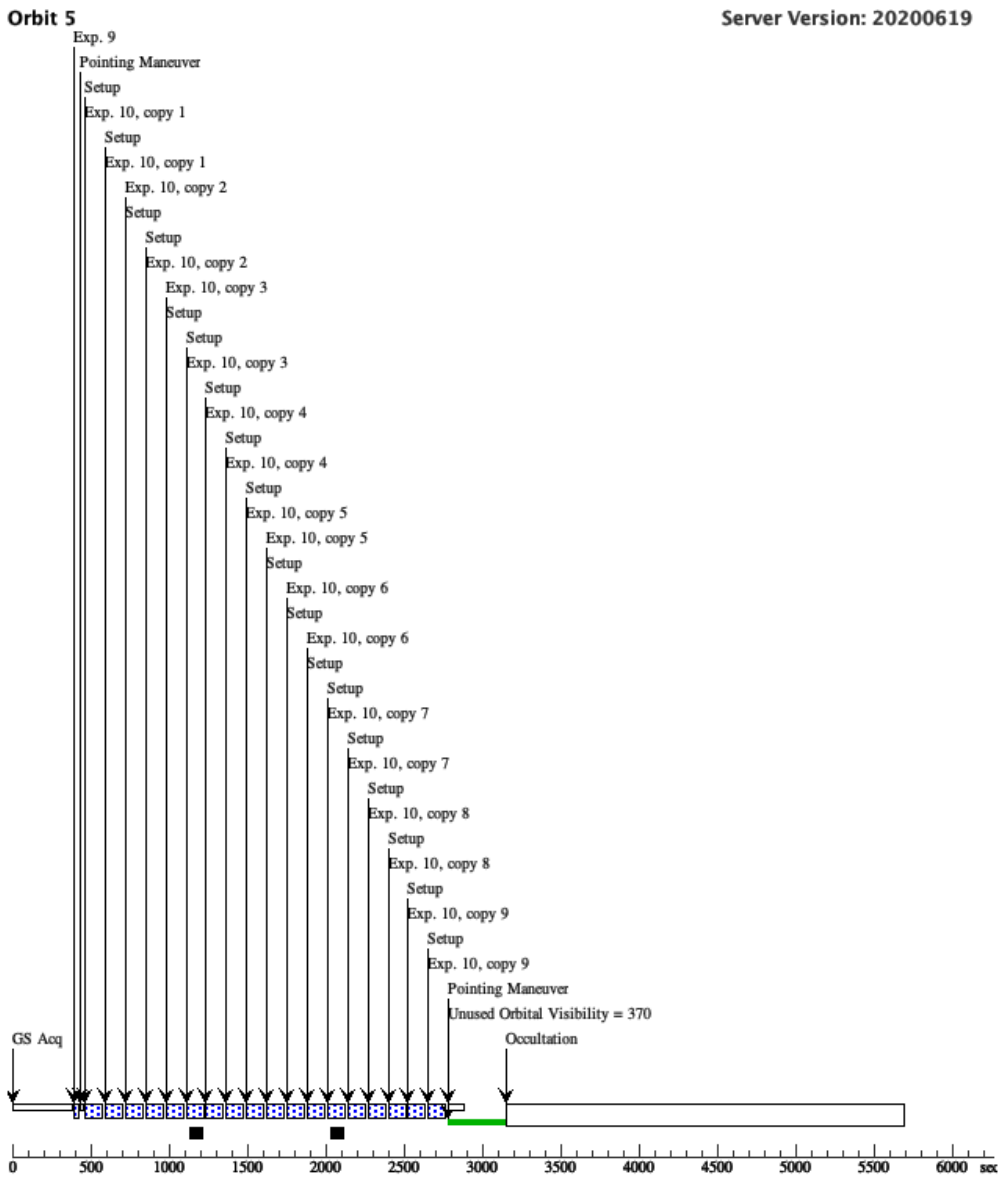
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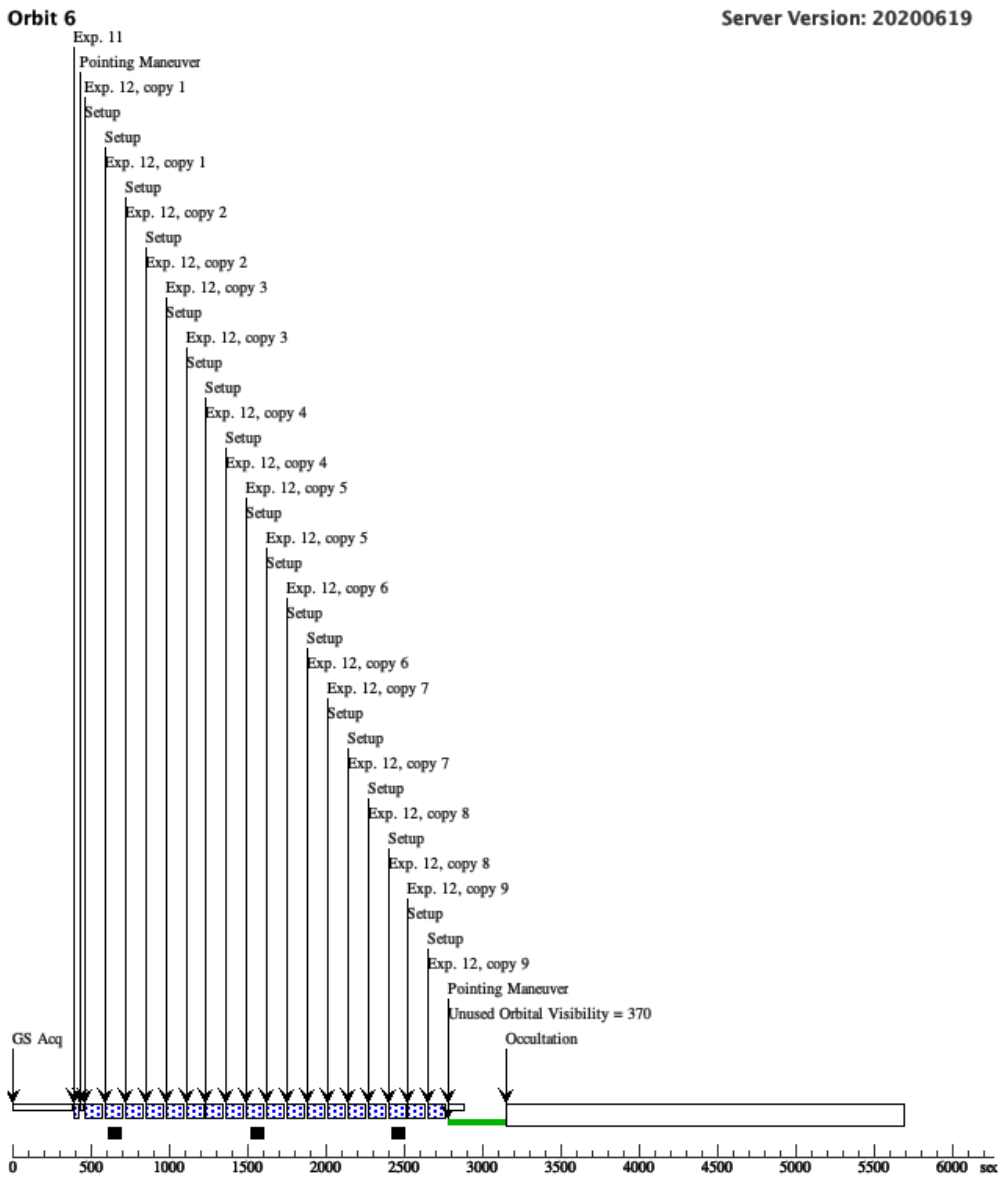
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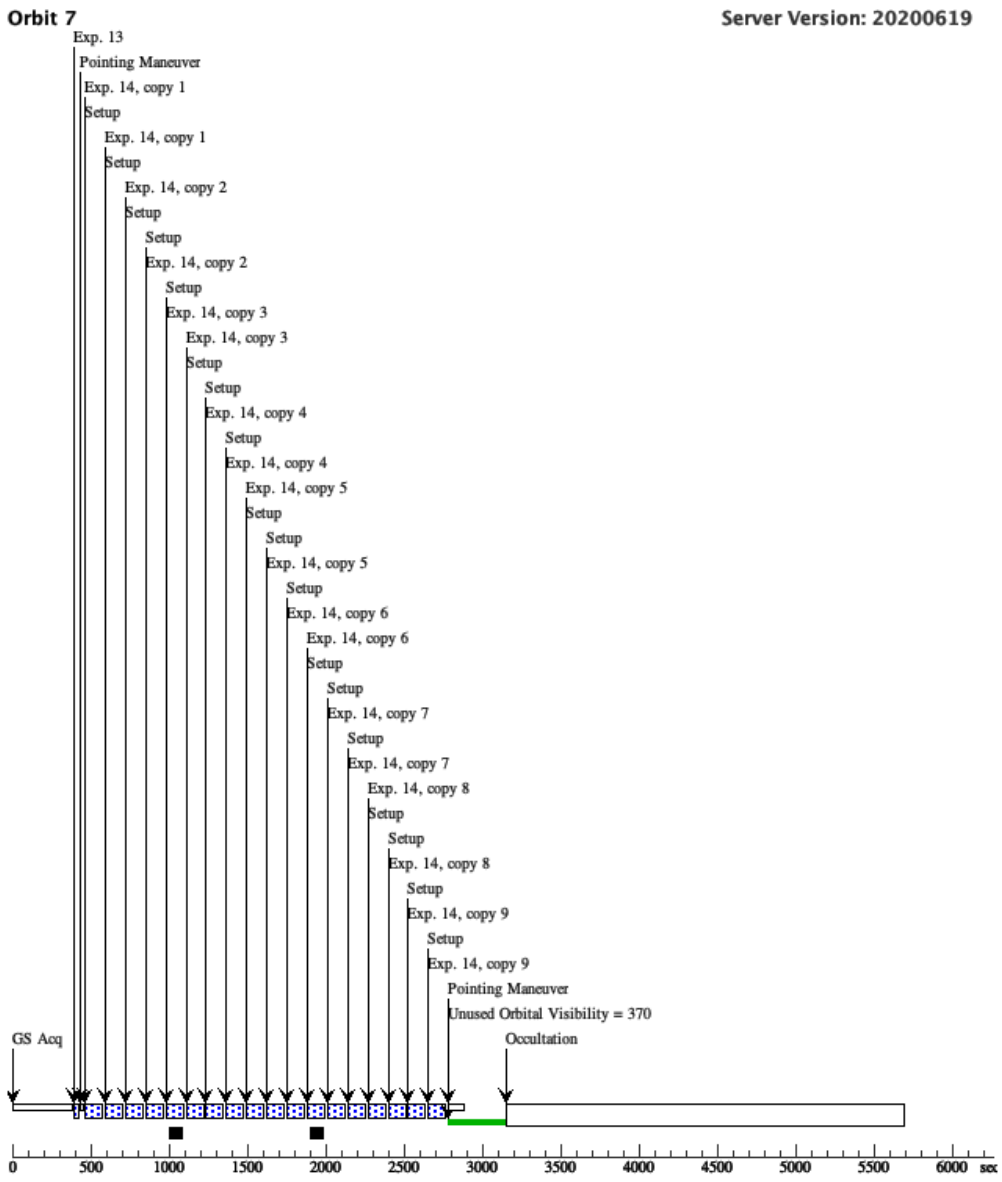
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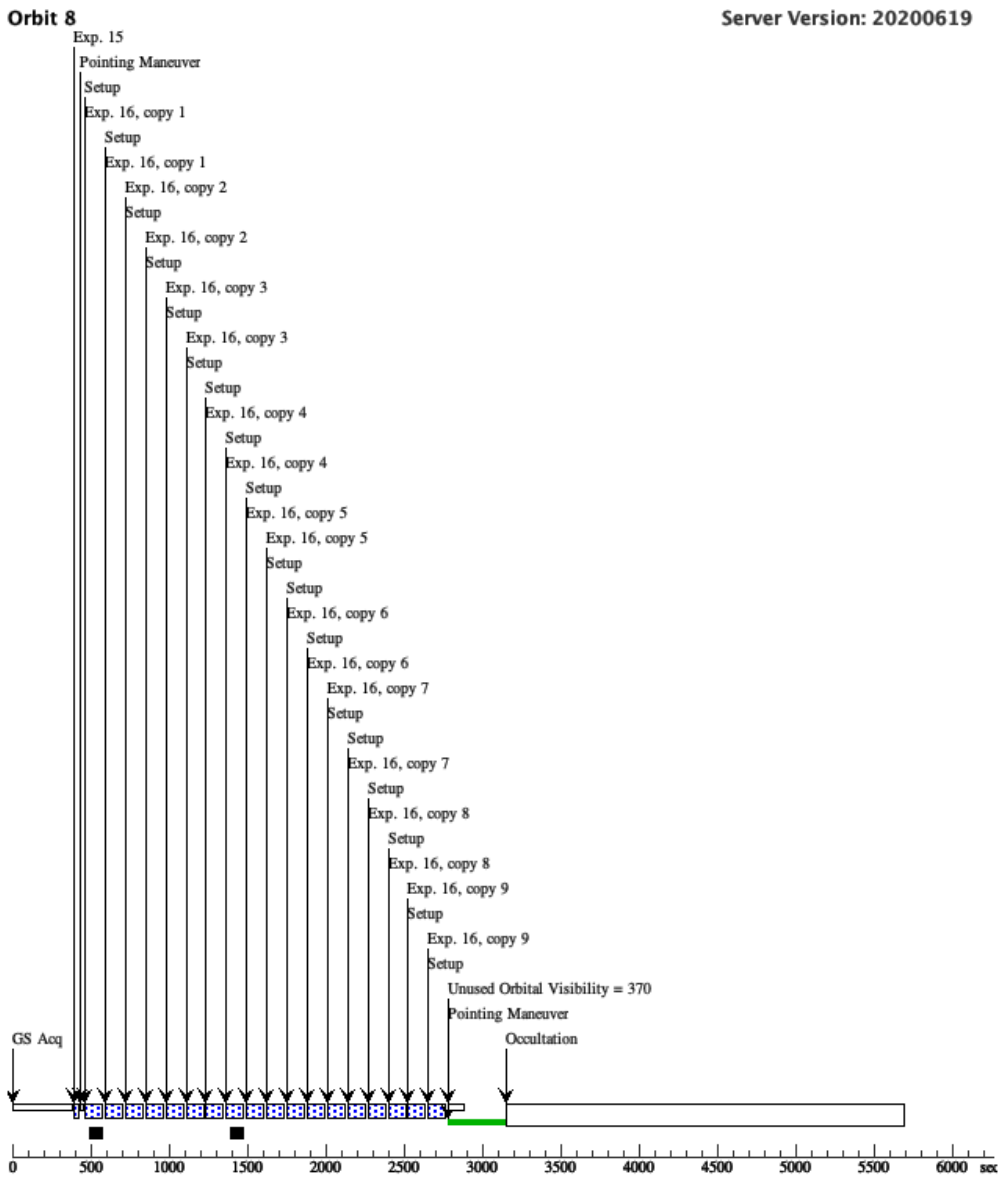
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Pointing Maneuver
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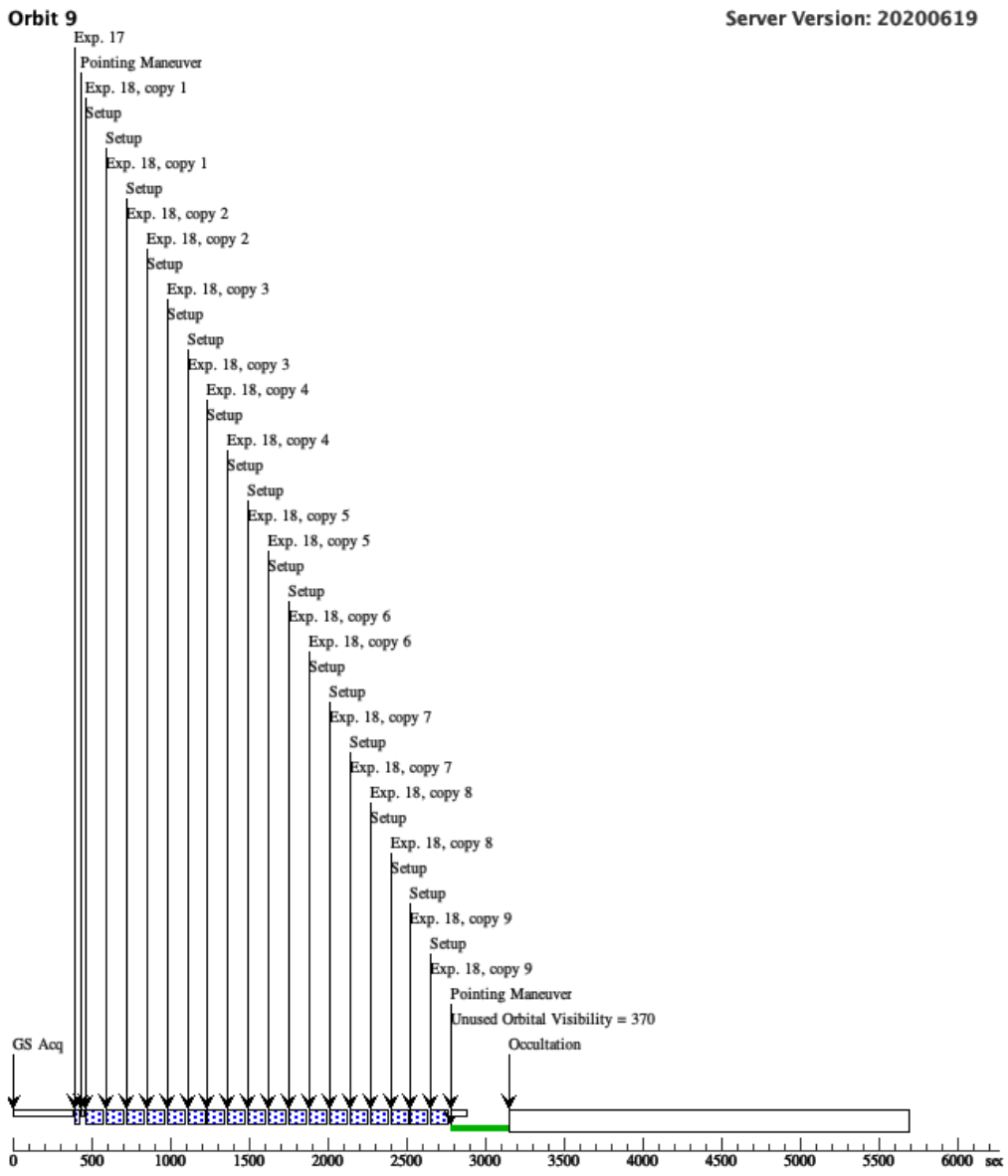
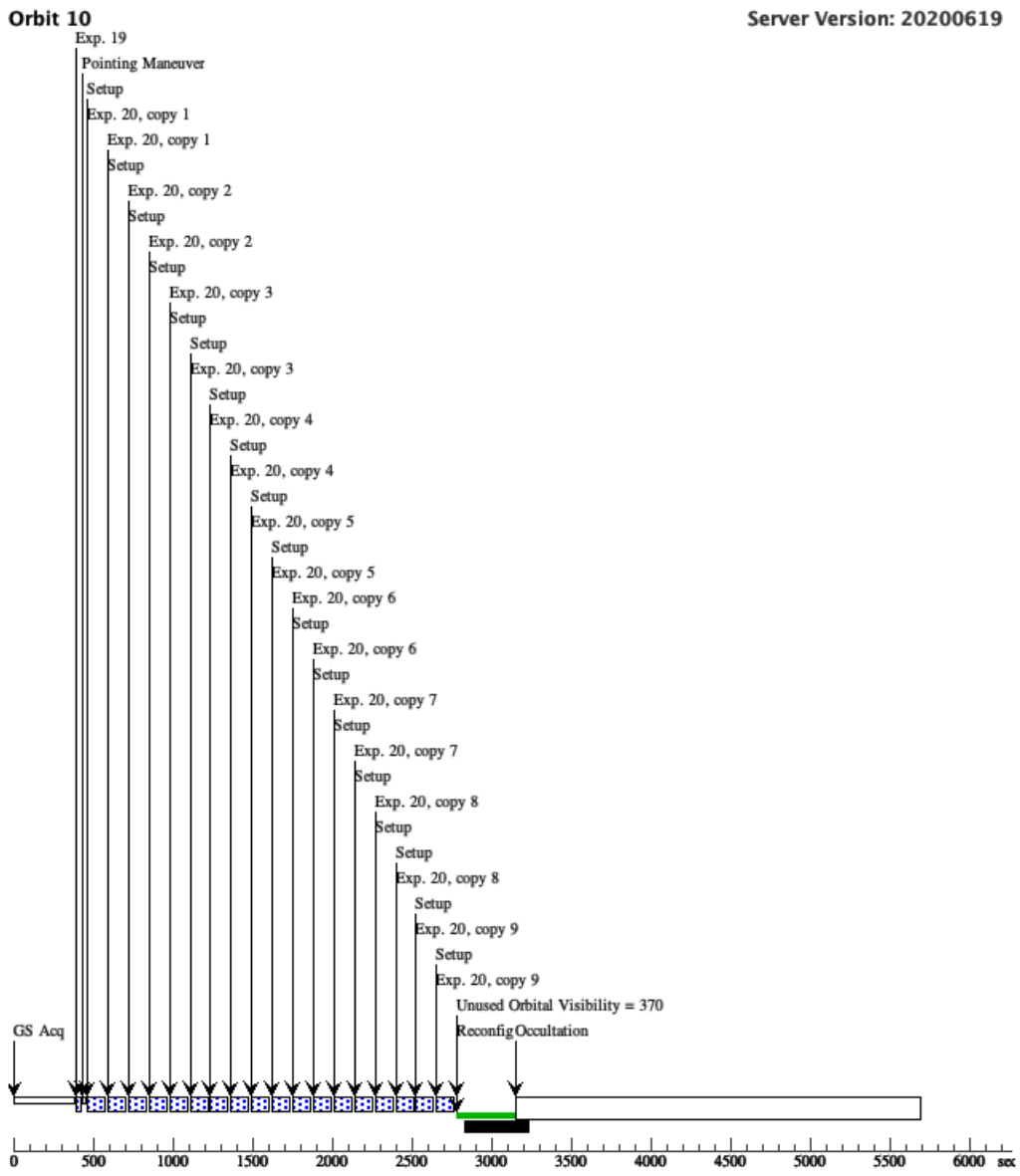
sec


Orbit 9
Server Version: 20200619
Exp. 17
Pointing Maneuver
Exp. 18, copy 1
Setup
Setup
Exp. 18, copy 1
Setup
Exp. 18, copy 2
Exp. 18, copy 2
Setup
Exp. 18, copy 3
Setup
Setup
Exp. 18, copy 3
Exp. 18, copy 4
Setup
Exp. 18, copy 4
Setup
Setup
Exp. 18, copy 5
Exp. 18, copy 5
Setup
Setup
Exp. 18, copy 6
Exp. 18, copy 6
Setup
Setup
Exp. 18, copy 7
Setup
Exp. 18, copy 7
Exp. 18, copy 8
Setup
Exp. 18, copy 8
Setup
Setup
Exp. 18, copy 9
Setup
Exp. 18, copy 9
Pointing Maneuver
Unused Orbital Visibility = 370
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec


Orbit 10
Server Version: 20200619
Exp. 19
Pointing Maneuver
Setup
Exp. 20, copy 1
Exp. 20, copy 1
Setup
Exp. 20, copy 2
Setup
Exp. 20, copy 2
Setup
Exp. 20, copy 3
Setup
Setup
Exp. 20, copy 3
Setup
Exp. 20, copy 4
Setup
Exp. 20, copy 4
Setup
Exp. 20, copy 5
Setup
Exp. 20, copy 5
Exp. 20, copy 6
Setup
Exp. 20, copy 6
Setup
Exp. 20, copy 7
Setup
Exp. 20, copy 7
Setup
Exp. 20, copy 8
Setup
Setup
Exp. 20, copy 8
Setup
Exp. 20, copy 9
Setup
Exp. 20, copy 9
Unused Orbital Visibility = 370
GS Acq
Reconfig
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec